NOAA Fisheries Protocols for Longline Surveys

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U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

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Introduction

The National Marine Fisheries Service conducts stock assessment surveys in all regions of the U.S. to provide current status of stocks information for managed species. The gears used and methods employed in these surveys vary among regions and with survey objectives, and many gears are used by more than one region. Recently, the Assistant Administrator of Fisheries, Dr. Bill Hogarth, assigned all regions with the task of establishing national protocols for gears/surveys used for stock assessment analysis. One gear type used by at least three regions (AFSC, NEFSC and SEFSC) is bottom longline gear.

The objectives of bottom longline surveys differ among regions. The AFSC employs bottom longline surveys to provide information on the relative abundance and size composition of the sablefish, shortspine thornyhead, Greenland turbot and rougheye and shortraker rockfishes. NEFSC bottom longline surveys target large and small coastal sharks with a primary interest of providing tagging opportunities, with additional objectives for developing indices of abundance, distributions and size structure. SEFSC bottom longline surveys are used to provide indices of abundance and size distributions for large and small coastal sharks, red snapper, red grouper and other commercially important species in the Gulf of Mexico (GOM) and western North Atlantic.

Each regional survey uses a different sampling design, different type and number of hooks, different baits, different mainline length and strength, and a variety of other variations; therefore a standard bottom longline gear protocol suitable for all regions and for all objectives is not practical. For example, if the primary objective of a survey is to catch as many individuals of a species as possible, the protocols to accomplish this goal will be very different from a survey whose primary objective is to determine distribution and abundance of a suite of species. If a survey targets a specific species, the gear and hooks may change to maximize the efficiency of the gear for the species of interest.

The purpose of this document is not to identify differences between regional gear and procedures, but to determine which protocols may be common to all regions and should be established as national standards. National protocols are procedures that should be implemented in any survey

using longline gear. The NOAA expectation is that with proper implementation of these protocols, sources of potential bias or variability will be reduced and the quality of data will be enhanced.

NOAA Fisheries Longline Survey Protocols

Survey Operational Procedures

Problem Statement
In all types of stock assessment surveys, standardization of gear and procedures is critical for maintaining survey consistency. With longline gear, factors such as length of longline, number of hooks, types of hooks, hook size, location of sets, bait type, length of set, direction of set, sea state, soak time and a variety of other considerations, can affect gear performance. Written protocols specifying how these and other factors will be addressed in a given survey are important to ensure consistency. Another advantage of establishing written protocols is to ensure that scientists and vessel officers and crew will maintain continuity in procedures as personnel and vessels change over time.

Protocol 1
Each Science Center will provide a written Operations Plan to their staff and the crew of the survey vessels that provides clear and unambiguous definitions of all procedures required to properly conduct longline sampling. The Operations Plan will be discussed by the chief scientist and the vessel crew at the start of each survey and again when crew changes occur. The Operations Plan may include, but is not limited to, the following issues:

- a.) Duration of set
- b.) Length of longline and number of hooks deployed
- c.) Direction of sets
- d.) Bottom topography
- e.) Location of sampling sites, and procedures to use if station occurs over rough bottom
- f.) Gear damage and repeat criteria
- g.) Criteria for determining the success of a longline set and procedures to use if a set was unsuccessful.
- h.) Gear and bait preparation
- i.) Vessel and winch operation during set deployment and retrieval
- j.) Defining responsibility for decisions regarding various aspects of the operations.

Discussion
All established NOAA Fisheries longline surveys have some form of an operations plan for scientists, officers and crew of the survey vessels. Lack of clarity or ambiguity in operational plans can lead to decisions, which could influence survey catchability. By ensuring annual updates to the operations plans as changes occur and by increasing the detail in these plans, errors of individual interpretations can be minimized. Also, formalization of communications between scientists and vessel officers and crew should result in increased consistency in surveys over time.

Longline gear construction, repair and maintenance

Problem Statement

Standardization of longline gear for a given survey, and the decision making process in determining when gear should be repaired or replaced, can have profound effects on gear efficiency. Longline gear used for stock assessment surveys is considered to be a sampling device, which should be maintained to assure uniformity for comparative purposes. Chafed or kinked gangions, dulled or bent hooks, and other gear related factors that could influence the catching ability of longlines should always be corrected upon detection. In fact, due to the passive characteristics of longlines, any differences between individual hooks or gangions that might affect fish behavior in taking the bait should be eliminated to the extent practicable. Also, any damaged gear that might result in an escape instead of a successful capture can have notable effects on results.

Protocol 2

A detailed description of all longline gear used in stock assessment surveys will be maintained by each Science Center and included in an Operations Plan. Each plan must contain a description of the materials used including the qualities of materials considered important for proper function of the gear. Also included in the plan should be a schedule for replacement of gear, criteria for repair or replacement of gear, and any requirements for proper storage of gear while not in use.

Discussion

The intent of this protocol is to ensure that all longline sets have a high quality of gear integrity, and that damaged gear is replace upon detection. Included in the Operations Plan should be a procedure for checking each gangion and hook before and after each set. To the extent practicable, the Chief Scientists should ensure that new or good condition mainline, gangions and hooks are used at the start of each longline survey.

Regional Protocols

The protocols adopted by each region to accomplish their surveys are driven primarily by survey objectives and logistics. For this reason, it was deemed impractical to attempt to develop detailed national protocols that applied to all regions. The two broad national protocols identified in this document were selected because they apply to any longline survey (or survey using any other type gear), regardless of objectives or logistics. Any successful survey must standardize the gear and the procedures by which the sample is taken, although this does not imply that each region should use the same gear or procedures.

The appendices to this document provide a brief description of how each region conducts their longline surveys. The description of the surveys does not contain the detail of an “operational plan,” but one of the protocols adopted for all NOAA surveys is that an operational plan be prepared and periodically updated. Thus, anyone seeking more detailed information on survey procedures should request a copy of the regional operational plan for the survey of interest.

Appendix 1

Southeast Fisheries Science Center Standard Operating Protocols for Bottom Longline Surveys

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southeast Fisheries Science Center

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Southeast Fisheries Science Center Historical Overview of Longline Surveys

The Southeast Fisheries Science Center (SEFSC) began collecting fisheries resource data in the Gulf of Mexico (GOM), Caribbean Sea and Atlantic Ocean in 1950. Over the years, SEFSC has conducted a number of projects using longline gear. The projects have targeted a variety of species including swordfish, bluefin tuna, tilefish, reeffish and sharks. The historical data base contains numerous records of surface, off-bottom and bottom longline sets in the GOM, western North Atlantic and Caribbean.

Most of the longline work in the 1950s and 1960s was exploratory in nature, and the main intent was to identify underutilized resources that might support commercial fisheries. Gear used in early surveys was “Yankee gear” or rope-type gear that has been demonstrated to be less efficient than currently used monofilament mainlines. Most exploratory work was non-random in nature and while useful in qualifying catches it was not particularly good for quantifying catch. It was not until the early 1970s with the abolition of the Bureau of Commercial Fisheries (BCF) and formation of the National Marine Fisheries Service (NMFS), that serious consideration was given to standardized sampling to facilitate population estimation.

During the 1970s and 1980s, several studies were conducted to determine whether longline gear would be useful for stock assessment surveys. These studies were target-specific efforts that yielded mixed results using surface, off-bottom and bottom longline gear. None of these studies led to implementation of long-term stock assessment surveys.

Prior to 1995, little fishery independent monitoring of small and large coastal shark populations had occurred in the GOM and only sporadic or localized surveys had been conducted in the western North Atlantic. Beginning in 1995, the SEFSC initiated a pilot study to develop survey methodology and a sampling strategy for assessment of coastal shark populations in the GOM. Longline gear similar to that used in the commercial shark fishery was deployed at randomly selected stations within contiguous 60 nautical mile (n. mi.) grids throughout the GOM. The survey methodology and gear design used in those surveys proved effective for capturing many of the small and large coastal sharks regulated under the auspices of the 1993 Fisheries Management Plan (FMP) for Sharks of the Atlantic Ocean (NOAA, 1993). Subsequent to the initial 1995 pilot study, annual surveys were implemented to assess the status of shark stocks in throughout the GOM and in the U.S. western North Atlantic Ocean from the Florida Keys to Cape Ann, MA. In 2000, survey methodology and design was modified to include deeper waters where snapper and grouper species occur.

Protocol 1: Survey Operational protocol.

Sub-Protocol 1a: Vessel requirements

Bottom longline projects can be supported by a variety of vessels and the minimum vessel requirement for longline operations is defined by a vessel's hydraulic system capabilities or electrical power capabilities sufficient to run a self-contained longline reel/hydraulic reservoir system. Vessel length can be a concern since with larger vessels it is possible to support a wider variety of scientific objectives than with smaller vessels due to work space and crew and scientists accommodations. On a large vessel it is possible to remain at sea for longer periods and to work a full 24 hr work cycle, whereas on a smaller vessel it is generally not feasible to carry enough crew and scientists to support a 24 hr work cycle in addition to greater limitations for days away from port (limitations for provisions and bait supply). Smaller vessels are more prone to be affected by sea conditions, but on the other hand, they are more maneuverable than larger vessels and the shorter distance from the ship's deck to sea surface facilitates closer contact with large specimens brought alongside. SEFSC projects have been conducted from vessels ranging in length from 40 - 225 ft (12 - 67 m), with at sea endurance from 1 - 23 days.

Sub-Protocol 1b: Measure survey gear

The longline spool holds approximately 5 nautical miles (n. mi.) monofilament line (900 - 1000 lb; 409 - 454 kg test). Prior to bottom longline deployment, the mainline is attached to a high flyer (radar reflecting buoy). High flyers are attached at both ends of the deployed mainline for visual reference and to facilitate gear retrieval. As the bottom longline is deployed the vessel's GPS is used to determine distance covered. Because of the constant cutting and reattachment of the mainline and potential loss of sections of line over the course of a survey, the mainline is not marked in sections and the length of mainline deployed is based on GPS intervals. One-hundred gangions (monofilament leaders with AK snap attachment clip and hook) are attached to 1 n. mi. of mainline approximately equidistantly (about every 60 ft or 31 m)) throughout the set. Gangion spacing is determined by GPS (i.e., at 1/10 n. mi. 10 evenly spaced gangions should have been deployed) and n. mi. increments are relayed to the gear set crew by hand-held 2-way radios. Weights (8 - 10 kg) are attached to the beginning, middle and end of the bottom longline to prevent gear from rising in the water column, as well as to minimize horizontal movement. After the end weight is attached to the bottom longline gear, the mainline is cut and attached to the second high flyer. Prior to the gear haulback, the mainline is reattached to the remaining line on the spool using a reef knot with the tag end crimped to the mainline.

Buoy lines (or drop lines) are continuations of the mainline and are not separate gear components but are created by deploying an adequate amount of mainline monofilament for tethering high flyer buoys to the bottom longline gear.

To create high flyer buoy lines for attaching the high flyers to the mainline:

1. The bottom depth is determined from the ship's echosounder and the first high flyer is attached to the mainline and deployed.
2. As the vessel steams forward enough mainline is deployed to achieve at least a 3:1 buoy line scope ratio based on the bottom depth (i.e., to create a high flyer buoy line in 20 m bottom depth 60 m of buoy line are required; often for deepwater sets the ship's

GPS can be used to determine when an adequate amount of buoy line has been deployed, otherwise buoy line lengths are estimated by the gear set crew).
3. Once the correct amount of buoy line is deployed the first bottom weight is attached to begin the 1 n. mi. measure of bottom longline gear.
4. Gangions and the midweight are attached followed by the remaining gangions.
5. The final longline set weight is attached and the buoy line for the last high flyer deployment is created by deploying enough mainline for a 3:1 scope ratio.
6. The set is completed by attaching cutting the mainline and attaching the final high flyer.

Sub-Protocol 1c: Longline set and haulback events

To properly calculate catch per unit effort (CPUE) and a variety of additional statistical analyses, it is important to document longline set, gear soak and longline haulback events. There are 4 critical events; first high flyer deployed (beginning of the set), last high flyer deployed (end of the set), first high flyer retrieved (beginning of haulback) and last high flyer retrieved (end of haulback). Minimum data elements required for each event are the date, time, bottom depth, latitude and longitude.

Sub-Protocol 1d: Set duration and length of longline deployed

Standard sets are 1 hr in duration with 100 hooks attached along 1 n. mi. of mainline. There are a number of situations that can affect the haulback duration including; high catch rates where data reporting requirements and tagging necessitate slowing the retrieval process, large fish entangling gangions and other gear components, gear entanglement with bottom obstructions. If the haulback is delayed, some of the hooks deployed near the end of the set soak for more than the 1 hr standard. However, since the time event is recorded for the final high flyer brought aboard to end the haulback, extended haulback times are documented.

Gear soak time is an important element in calculating fishing effort (catch per unit effort, CPUE, expressed as the number of captures by species/100 hook hr). Soak time is defined during SEFSC surveys, and often for other surveys, as the time between deployment of the last high flyer to end the set to the time of retrieval of the first high flyer to begin haulback. Since the beginning and end of the soak period are essential data elements, soaks that deviate from the standard 1 hr can be accounted for during data analysis. It is possible to use critical events for re-evaluating effort calculations if needed since the 4 critical events are data elements (begin set, end set, begin haulback and end haulback).

Sub-Protocol 1e: Direction of sets

Ideally, sets are conducted parallel to depth contours with reasonable effort made to maintain a uniform bottom depth and vessel speed throughout the set. Maintaining a uniform set depth can be difficult and may not be feasible when setting gear along areas of high relief or in high winds or currents. Gear is set from the stern of the vessel and communications between the deck crew and helmsman are maintained via hand held two-way radios. Set procedures are generally standard and should be maintained for consistent effort. Primary set procedures and events include; wheel house to deck notification of the set event, deploying the first high flyer, attachment of the first weight, attaching gangions at approximately equidistant increments, attachment of the mid-weight, completing gangion deployment, attaching the last weight, and deploying the last high flyer to mark the set termination point.

Sub-Protocol 1f: Bottom topography

Inherent to broad-based bottom longline surveys is the likelihood of encountering a variety of sea bottom types and profiles. Research and charter vessels are, as a rule, equipped with echosounders suitable for providing an electronic view of bottom profiles. Using an echosounder to assess bottom type is often complicated by a number of factors that include bottom depth, bottom type (soft bottom verses hard bottom), sea conditions, and vessel speed across bottom and echosounder settings. It is recommended that experienced ship helmsmen operate echosounders since a number of variables may affect generated displays.

Sub-Protocol 1g: Location of sampling sites, and procedures to use if station occurs over rough bottom

Examining the sea bottom topography with an echosounder prior to a bottom longline set can help prevent gear damage and survey delays. Typically, when bottom profiles appear prohibitive the ship's helmsman and a scientific representative cooperatively assess the bottom profile. For circumstances where the sea bottom profile appears to be prohibitive for gear deployment, a survey protocol was established to allow for movement of a pre-selected station 0.5 n. mi. in any direction from the originally selected point provided a newly selected point does not fall outside of the predetermined depth strata (if designated). For most surveys this is generally sufficient for relocating a set. For those cases when a 0.5 n. mi. search does not provide an alternative set location, after discussion between the helmsman and the watch leader or chief scientist, the station is dropped. A new location may be selected either through a predetermined randomization procedure that follows the criteria of the original survey design, or by some other form of directed sampling station selection. In some cases, it is necessary to move stations due to ship traffic, commercial or recreational fishing activity, shoals or other factors that preclude setting 1 n. mi. of longline gear.

Sub-Protocol 1h: Gear damage and repeat criteria

Gear damage can lead to lost survey time. Often gear damage can be minimized by being cognizant of bottom features along longline set locations, maintaining proper set direction, and maintaining proper vessel orientation during haulback (e.g., caution not to tangle the line in the propeller). However, gear damage can occur even during the best of circumstances. Notations concerning gear damage are made in the data sheet comment section and are a matter of record for associated bottom longline data. Data entry procedures used by SEFSC allow for gear codes that describe gear damage. Data collected from sets with gear damage is not disregarded. If gear damage was a result of bottom features, the set is not repeated. If gear damage was a result of a problem with gear deployment (e.g., the mainline breaks during the set), the set is repeated.

Sub-Protocol 1i: Criteria for determining the success of a longline set and procedures to use if a set was unsuccessful

A fully successful bottom longline set is a scenario where established protocols were followed throughout the set and during haulback there were no indications of damage or fouling of the mainline, gangions or hooks. Longline sets that are considered less than successful are those were less than the full set of 100 hooks are retrieved or components of the longline gear were damaged or lost. Less than successful sets are not repeated but the number of hooks retrieved and any associated problems are noted as comments associated with longline data. Due to current data formatting limitations, the data entry format used by SEFSC accounts for the number of hooks set but does not account for the number of hooks retrieved, however, future modifications to the data entry format will account for differences between hooks set and hooks retrieved. The only scenario where an unsuccessful set would be repeated would be if an unsuccessful set was the result of a correctable oversight by the set crew (e.g., bottom weights not used or adequate buoy line not deployed). For bottom longline sets that were inadvertently made across unfavorable bottom and the longline gear was damaged, entangled or lost, those sets are not repeated and the resultant data (from the longline portion that was retrieved) is included as a component of the survey data.

Sub-Protocol 1j: Gear and bait preparation

Gear and bait preparations are completed before arrival at the set location. Gangions and hooks are inspected for damage and baited with relatively uniform sized bait pieces suitable for the survey hook type. SEFSC surveys use a single bait type (i.e., Atlantic mackerel, *Scomber scomberus*) to minimize variability attributable to bait. When possible baits are double hooked by passing the hook barb twice through each bait piece.

Sub-Protocol 1k: Vessel and winch operation during set deployment and retrieval

Vessel speed while deploying the longline is 9.2 km/hr (5 knots). The ship's GPS is used to measure the 1 n. mi. set that begins when the first bottom longline weight is attached to the mainline; the 1 n. mi. set terminates after the last hook and last bottom longline weight is attached. The high flyer buoy lines are not included in the 1 n. mi. measure. Communications between the ship's helmsmen and set crew are maintained via hand-held 2-way radios. Gear haulback speed can vary from 0 - 5 knots depending on sea conditions and the number of captures. Often the capture of large specimens or numerous captures necessitates a slowing or stopping of the vessel.

Sub-Protocol 1l: Defining Responsibility

The lead scientist for bottom longline surveys (i.e., chief scientist or field party chief), is responsible for preparing survey instructions, assembling the scientific compliment, handling logistics for loading gear and bait deliveries, and selecting stations. Station locations are made available to vessel command at least one month prior to surveys. Daily scientific operations, sampling procedures and routine gear maintenance (preparing the gear for the set) are the responsibility of the lead scientist or designated watch leader. The lead scientist or watch leader participates in discussions with the ship helmsman or other officer on watch concerning the feasibility of conducting longline operations when a predesignated location may need to be moved due to ship traffic, fixed platforms or presence of prohibitive bottom features.

Protocol 2: Longline Gear Construction, Repair and Maintenance

Longline gear components and repair

Bottom longline gear is useful for assessing a variety of fishery issues. Whether target species are large elasmobranchs or small teleosts, bottom longline gear components and survey strategies can be modified to suit survey objectives. For surveys using bottom longline gear, standardization of operation protocols (for specific projects) is desirable in order to compare time series data between surveys or across years. Gear standardization is relatively uncomplicated provided survey design parameters and gear components are properly documented. Data elements that describe longline sets should include pertinent gear specifics (i.e., number of hooks and hook type).

Longline gear is typically deployed and retrieved with a hydraulic longline reel. Bottom longline gear typically consists of monofilament mainline, monofilament gangions (monofilament leaders with AK snaps for attaching gangions to the mainline and hooks attached with crimps), monofilament blocks, a rail roller or line retrieval block, high flyers, polyball floats, and weights.

Reel, blocks, and rollers

The longline reel is either connected to the vessel's hydraulics or may be equipped with a self-contained hydraulic unit. Mainline is spooled onto the reel prior to sailing. Mainline may be deployed or retrieved through monofilament blocks; sometimes a roller mounted on the ship's cap rail is used for retrieval. If the position of the longline reel is not optimal, the mainline may then be redirected by the use of a series of monofilament blocks to the point of setting or haulback. The longline reel, rail roller, and blocks should be inspected and greased regularly and protected from the elements when not in use.

Mainline

Factors that affect the choice of mainline test strength for longline surveys include target species size, vessel specifics and maneuverability, and bottom type. SEFSC bottom longline surveys use 900 - 1000 lb (409 - 454 kg) test monofilament mainline due to the capture of large elasmobranchs and the variety of bottom types in survey areas. Mainline should be inspected regularly for damage and replaced in sections or in its entirety as needed. Sections of mainline are joined using appropriately-sized metal crimping sleeves and a hand-held crimping tool on the appropriate setting. Care should be taken to ensure that crimps are neither too loose (line will pull through) or too tight (sleeve will cut into line and reduce strength under tension). Monofilament mainline should be protected from light exposure when not in use.

Gangions

For SEFSC bottom longline surveys, gangions are constructed using monofilament leaders, AK snaps for attaching gangions to the mainline, #15/0 circle hooks and crimping sleeves. For SEFSC projects gangions are made of 730 lb (287.4 kg) test strength monofilament. Gangion length depends on the freeboard of the vessel (most SEFSC gangions are 12 ft or 3.7 m) and length should be consistent within the scope of each project. A sufficient number of gangions should be assembled prior to sailing to allow for 2 full sets of gear (for SEFSC bottom longline surveys, 200 gangions). Gangions should be inspected after each set for signs of wear or damage to monofilament, weakening of AK snaps, and bent or damaged hooks. Sleeves should be crimped using the appropriate setting on the crimping tool to avoid crimps that are either too loose or too tight.

High flyers
High flyers are used at the beginning and end of each set and are comprised of diamond-shaped radar reflectors (metal or plastic) attached to the end of a buoy pole (typically 12 - 15 ft; 7.3 - 4.6 m length), which passes through a center through-hole in an inflatable polyball float. High flyers are weighted at the bottom with metal counter weights to ensure that they remain upright in the water. Reflective tape is placed on the radar reflector and during inclement weather and at night, battery-operated strobe lights are attached to the pole near the radar reflector. The high flyer assembly is tethered to an additional polyball float to facilitate recovery during haulback. Monofilament and snaps connecting elements of the high flyer assembly should be checked regularly for wear, particularly when monofilament is used to connect weights to the high flyer pole. Strobe lights should be checked daily and batteries changed as needed.

Weights
Short sections of anchor chain are used to weight the longline along the bottom and to help maintain position on the bottom by hampering drift. Weights are typically used at the beginning, middle, and end of each set for SEFSC surveys. Additional weights may be used in areas of high current velocity. However, excessive use of weights can result in the high flyer being pulled under the surface or the mainline breaking. Monofilament and AK snaps used to attach weights to the mainline should be inspected daily for wear and damage.

Buoy lines
Buoy lines used to attach high flyers to the distal ends of a bottom longline set are simply additional mainline monofilament deployed between the last weight and the high flyer. Generally, a 3:1 (3 times bottom depth) scope ratio is adequate for buoy line lengths. At the beginning of a set, the high flyer is deployed and the navigation coordinates are recorded. Using the ship's navigation system (GPS) sufficient buoy line scope is estimated (based on the bottom depth as read from the ship's echosounder) prior to attaching the first weight to the mainline. After all hooks and the last weight are attached, the navigation coordinates are again recorded and scope ratio is again estimated prior to attachment of the final high flyer.

Appendix 2

Northeast Fisheries Science Center Standard Operating Protocols for Bottom Longline Surveys

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Northeast Fisheries Science Center Historical Overview of Longline Surveys

The Northeast Fisheries Science Center (NEFSC) began using longline gear to collect resource for sharks, tuna and swordfish in the 1950's. In 1986, the NEFSC Apex Predators Program conducted a longline cruise that represented the first systematic survey of sharks covering most of the U.S. Atlantic coast from southern New England to mid-Florida in depths from 5 - 200 m. Pre-determined stations were positioned approximately 30 n. mi. apart, with additional (tagging only) stations in regions of high shark abundance. The cruise was designed to obtain baseline information on the abundance and distribution of large pelagic fishes, primarily sharks, using standard pelagic longline gear. By 1989, a shift in the survey objectives was made away from targeting pelagic fish and towards large coastal sharks. This survey covered the waters from Tampa, FL to Southern New England (SNE). The gear was weighted and the bottom longline survey was initiated.

In 1995, NEFSC changed survey procedures and gear to mimic commercial gear used in the large coastal shark fishery and to increase shark tagging opportunities by deploying more gear with longer soak times. Changes to the NEFSC survey were: 1) gear changed from New England pelagic (rope mainline, rope and wire gangions) to Florida bottom longline (monofilament mainline and gangions), 2) soak time increased from 1 to 3 hrs, 3) bait changed from mackerel to spiny dogfish, 4) stations limited to depths between 5 - 40 fm (9 - 73 m), and 5) longline fished entirely on the bottom, eliminating the pelagic sets of the previous surveys, 6) number of hooks increased from 100 to 300.

Protocol 1: Survey Operational protocol.

Sub-Protocol 1a: Measure survey gear

The longline spool holds approximately ten miles of monofilament mainline line (900 - 1000 lb test or 407 - 454 kg test). Gangions are attached equidistantly approximately 60 ft (18.3 m) apart throughout the set until 300 gangions have been deployed. A single weight (sash weight) is attached every 15 gangions and a triple sash weight and a marker buoy are deployed every 50 gangions. At each end of the line 4 sash weights and a high flyer are attached and the line is cut. Distance between the weights and the buoys is dependant on water depth: up to 25 fm (31 m) a 2:1 ratio of line to depth is used, past 25 fm a 3:1 ratio is used this distance has no bearing on the length of the actual fishable longline. At retrieval the line is reattached to the remaining line on the spool using a barrel knot. Because of the constant cutting and reattachment of the line and potential loss of sections of line over the course of a survey, the line is not marked. Distance between the gangions is estimated based on wraps on the longline winch. The ultimate length of longline deployed is based on vessel bridge determination using GPS locations of the start and end of the set. Gangions are 12 ft (3.7 m) in length. Gangion length is based on freeboard of the ship and does not affect fishing.

Sub-Protocol 1b: Longline set and haulback events

To properly calculate catch per unit effort (CPUE) and a variety of additional statistical analyses, it is important to document longline set and haulback events. There are 4 critical events; start of and end of longline set, and start and end of haulback. These locations are based on the deployment and retrieval of the high flyers and associated weights. Minimum data elements required for each event are the date, time, bottom depth, latitude and longitude. CTD casts are made after each set.

Sub-Protocol 1c: Duration of set and length of longline deployed

Standard longline sets have a 3 hr soak time and 300 gangions are deployed. Duration of the haulback and subsequent soak times for some or all hooks can be highly variable in situations of high catch rates where data reporting requirements necessitate slowing the retrieval process, in cases where large fish are caught and gangions may be entangled, cases of longline entanglement with bottom obstructions or a variety of other problems in haulback are encountered. If the haulback is delayed, some of the hooks deployed near the end of the set may soak for more than the three hour standard.

Gear soak time is an important element in calculating fishing effort (CPUE). The longline soak time is defined during a NEFSC survey as the time between deployment of the last high flyer weight for the longline set to the time of retrieval of the first high flyer weight to initiate longline haulback. Total soak time is calculated as the time from the first hook in to the last hook out. This allows for time when the haulback length varies for unavoidable reasons (breakage, obstructions or a large number of fish). In addition, since the 4 critical longline events are data elements (begin and end set and begin and end haul), it is possible to use all critical longline events for re-evaluating effort calculations if needed.

Sub-Protocol 1d: Direction of sets

Bottom longline sets are conducted with the wind approximately 10 - 20 degrees off the starboard bow. Gear is set from the vessel stern and communications between the deck crew and scientists are maintained via hand held two-way radios. Bottom longline set procedures are generally standard and should be maintained for consistent effort. The wheelhouse will notify the watch chief with information on depth and current when station is reached and when they are in position to set. The watch chief notifies the bridge when the first high-flyer and set of weights are in the water. Additionally the deck notifies the wheelhouse when each marker buoy is deployed and the wheelhouse marks these positions on the plotter. When 10 hooks are left, the deck notifies the wheelhouse and the ship should be slowed to clutch; at the last 5 hooks, the ship is stopped and the deck will notify the wheelhouse if they need to backdown. When the end weights are attached, that position is marked for the log.

Sub-Protocol 1e: Bottom topography

Inherent to broad-based bottom longline projects is the likelihood of encountering a variety of sea bottom types and profiles. Research and charter vessels are, as a rule, equipped with echosounders suitable for providing an electronic view of bottom profiles. Using an echosounder to assess bottom type is often complicated by a number of factors that include bottom depth, bottom type (soft bottom verses hard bottom) sea conditions, and vessel speed across bottom and echosounder settings. It is recommended that experienced ship handlers operate echosounders since there are a number of variables that affect echosounder generated displays.

Sub-Protocol 1f: Location of sampling sites, and procedures to use if station occurs over rough bottom

Prior to setting the bottom is scanned for potential obstructions that may cause gear hang-ups. If such obstructions exist the ship handler and the Chief scientist determine the best course of action; this usually is a change of direction of the set.

Sub-Protocol 1g: Gear damage and repeat criteria

Notations concerning gear damage are always written on the data log sheets. Data collected from sets with gear damage is not disregarded. The bottom longline set is not repeated. Only the bottom longline sets where the gear is entirely lost are considered unsuccessful but those sets are not repeated.

Sub-Protocol 1h: Criteria for determining the success of a longline set and procedures to use if a set was unsuccessful

A longline set is deemed successful if established protocols were followed throughout the set, and there were no indications of damage or fouling of the line. Sets are not repeated. If gear is consistently damaged at this station, the station is dropped.

Sub-Protocol 1i: Gear and bait preparation

Gear and bait preparations are done before arrival at a longline set location. Gangions are inspected and baited with relatively uniform sized bait pieces suitable for the survey hook type; NEFSC large coastal surveys use uniform bait type (i.e., spiny dogfish, *Squalus acanthias*) in order to minimize a potential source of survey bias. Baits are cut approximately 1.5 inches length (3.8 cm) from the carcass log of spiny dogfish. In the log tail section, pieces are cut slightly lightly larger to account for tapering of the tail width.

Sub-Protocol 1j: Vessel and winch operation during set deployment and retrieval
Vessel speed while deploying the longline is adjusted to ensure proper deployment of the gear depending on the persons setting abilities. The main concern is equal spacing of the gangions to ensure consistent deployment.

Sub-Protocol 1k: Defining Responsibility
The lead scientist for bottom longline surveys (i.e., chief scientist or field party chief), is responsible for preparing survey instructions, assembling the scientific compliment, handling logistics for loading gear and bait deliveries, and selecting bottom longline stations. Daily scientific operations, sampling procedures and routine gear maintenance (preparing the gear for the longline set) are the responsibility of the lead scientist. The lead scientist will participate in discussions with the ship handler or other officer on watch concerning the feasibility of conducting longline sets when a predesignated location may need to be moved due to ship traffic, fixed platforms or gear or presence of prohibitive bottom features.

Protocol 2: Longline gear construction, repair and maintenance

Gangions:
Prior to sailing sufficient gangions need to be made are on hand to have 300 on the hook rack for immediate use, 300 spares in case the entire line is lost, and at least 200 spares to replace broken gangions in each set. This avoids having to lose time on board making gear. Gangions are made from 740 lb test (336 kg) clear L/P monofilament with a # 3/0 shark hook on one end and a #120 (6/0) AK longline snap at the other. A 12 ft length (3.7 m) of line is cut and the hook and snap are attached using the appropriate nicopress sleeve. Each sleeve is crimped 3 times at the appropriate setting for the sleeve. The appropriate tension on the nicopress tool can be determined by testing the crimps against pull. If the crimps are too loose the mono will pull through, too tight and the crimp will break. Periodically during the cruise gangions need to be checked for wear of mono, weakening of clips and bent or damaged hooks. Additionally, very curly and less than standard length gangions need to be replaced.

Buoys:
Two types of buoys are used on the survey cruise, a 24” (61 cm) polyform buoy can be used instead of a high flyer under calm conditions and when bridge personnel approve its use. Bullet or spongex floats are used to mark the line every 50 hooks.

Polyform: In general it is best to put rope baskets around the polyform buoys for ease in hauling them to the ship. A longline snap is connected to the buoy with double loop of mainline monofilament (900 - 1000 lb test or 405 - 454 kg). This loop needs to be checked for wear periodically and replaced as necessary. When deployed a “tag buoy” is attached to the polyform buoy or high flyer. This is a rigged bullet float attached to a loop in a 10 - 12 ft (3 - 3.7 m) line that has a longline snap which is clipped to the monofilament loop of the poly. The clip of the polyform buoy is attached to a loop in the mainline.

Bullet: Five bullet floats are used as markers on each set and 2 are used as tag buoys. Therefore, 12 buoys should be ready in case of loss. Two buoys should be rigged as tag buoys and 6 need to be available for use as markers. All bullets floats should be rigged with mainline monofilament (900 - 1000 lb test or 405 - 454 kg) and a gangion clip. The marker buoys are never attached directly to the mainline, they are attached to buoy droppers whose number is dependent on depth. All buoys should have reflector tape on the ends and the sides.

Weights:
Window sash weights are used to keep the longline in place on the bottom. Weights need to be rigged as single, triple and quadruple. Single weights are used every 15 hooks, triples are used at the buoys and quadruples are used at the ends. It is best to have 2 full sets rigged plus spares of each in case the entire line gets lost. Weights are rigged with a double loop of mainline monofilament (900 - 1000 lb test or 405 - 454 kg) with a longline snap. Multiple weights should be taped together with duct tape to prevent hands from being crushed. Monofilament needs to be checked daily for wear and replaced as necessary. Tape also needs periodic replacement.

High Flyers: High flyers are used at the ends of the longline in all but the best weather conditions and always at night. One is used at each end of the line. Poles are 15’(4.5 m) length, one end is encased in a 4" (10 cm) diameter piece of plastic pipe filled with cement and a few weights. Two bullet floats are placed in the middle and a radar reflector sits on the top. Bullets should be placed so that the pole sits upright in the water. A bridle is attached so that it keeps the high flyer upright as well, 2 longline snaps should be put on the bridle for decrease chance of loss. Reflector tape needs to be placed on the radar reflector as well as on the pole. At night a longline strobe with battery needs to be taped to the upper portion of the pole. These are activated when the pole becomes upright. They should be tested before use and the wire connections checks. Spare connections need to be on board as they often need to be replaced due to corrosion.

Buoy cart and droppers: A buoy cart is used to hold the buoy droppers. Droppers are made of 120’ (36.6 m)of 740 lb (336 kg) black monofilament with a loop on one end and a longline snap on the other. A loop is placed on the buoy cart spool and the first dropper is attached with the clip then wound on until the loop where the next one is attached etc. A minimum of 25 droppers are on the spool at all times.

Appendix 3

Alaska Fisheries Science Center Standard Operating Protocols for Longline Surveys

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southeast Fisheries Science Center

TABLE OF CONTENTS

Introduction

Alaska Fisheries Science Center (NEFSC) Overview of Bottom Longline Surveys

Sablefish (Anoplopoma fimbria) are a commercially important fish species in the northeast Pacific Ocean. Found along the upper continental slope, in Alaska they are caught primarily by longlines. Catches in the Alaskan EEZ have averaged 15,000 mt in recent years with an annual value of about $100 million. The fishery has been managed by an Individual Fisheries Quota system since 1995. Fishery-independent longline surveys have been conducted annually since 1978 to assess the relative abundance of this valuable resource. The survey abundance indices are combined with age, length, and fishery data to estimate absolute abundance and recommend catch quotas with age-structured models.

Since 1978, the U. S. National Marine Fisheries Service (NMFS), Alaska Fisheries Science Center (AFSC) has conducted annual longline surveys with Japan (Japan-U.S. cooperative longline survey, 1978-94) and alone (1987-present, domestic longline survey). The survey has covered the upper continental slope (1978-present) and selected gullies (1987-present) of the Gulf of Alaska and the upper continental slope of the eastern Bering Sea (1982-94, biennially since 1997) and Aleutian Islands region (1980-94, biennially since 1996). A unique aspect of this survey is that the charter vessel retains most of the catch after the scientific data are recorded. The survey lasts three months. The survey is conducted jointly by two components of the AFSC: the Auke Bay Laboratory and the Resource Assessment and Conservation Engineering Division.

History of survey

Sablefish have been exploited since the end of the 19th century by U.S. and Canadian fishermen. The North American fishery on sablefish developed as a secondary activity of the halibut fishery of the United States and Canada. Initial fishing grounds were off Washington and British Columbia and from there spread to Oregon, California, and Alaska during the 1920's. Since then, and up to 1957, the sablefish fishery was exclusively a U.S. and Canadian fishery, ranging from off northern California northward to Kodiak Island in the Gulf of Alaska. Japanese longliners began operations in the eastern Bering Sea in 1958. As the fishing grounds in the eastern Bering Sea were preempted by expanding Japanese trawl fisheries, the Japanese longline fleet expanded to the Aleutian Islands region and the Gulf of Alaska. Heavy fishing by foreign vessels during the 1970's led to a substantial population decline and fishery regulations in Alaska, which sharply reduced catches. Data collection from sablefish fisheries in Alaska began in 1963. Catch, effort, age and length data have been collected to compute relative abundance indices (catch/hook), age and length compositions.

With passage of the Magnuson Fisheries Conservation and Management Act in 1976, foreign vessels fishing in U.S. waters were required to provide either fisheries research or markets for this privilege. This requirement sometimes is called the “fish-and-chips” policy. The Japan Fisheries Agency began a longline survey for sablefish in Alaska in 1978 as a “chip” to trade for continued commercial fishing for sablefish in U.S. waters.

The Japan-U.S. cooperative longline survey was conducted annually from 1978 to 1994. In 1987, the AFSC began an annual survey intended to replace the cooperative longline survey so that a U.S. vessel, rather than a Japanese vessel, would conduct the survey for what had become a wholly U.S. fishery in 1988. The two surveys overlapped for several years to compare and test for differences between them and thus link the time series of standard longline surveys. By 1994, statistical analyses by Kimura and Zenger (1997) showed that enough data had been collected to complete a valid comparison. As a result, the cooperative longline survey was discontinued after 1994. The annual longline survey begun by the AFSC in 1987 has continued to the present.

Survey objectives

The survey objectives are: 1) Determine the relative abundance and size composition of the commercially important species: sablefish, shortspine thornyhead (*Sebastolobus alascanus*), Greenland turbot (*Reinhardtius hippoglossoides*) and rougheye and shortraker rockfishes (*Sebastes aleutianus* and *S. borealis*); 2) Determine migration patterns of sablefish, shortspine thornyhead, and Greenland turbot by tag and release methods; and 3) Determine the age composition of sablefish through otolith collections.

Survey description

The survey covers the upper continental slope and selected gullies of the eastern Bering Sea, Aleutians Islands region, and Gulf of Alaska (Figure 1). The survey covers nearly all areas where adult sablefish are found. Depths sampled during the survey of the upper continental slope range from about 150-1,000 m (82-547 fm). Sampling occurs during the summer and lasts 3 months. Survey operations are conducted using a chartered U.S. longline freezer vessel with overall length of about 55 m (150 ft).

Protocol 1: Survey Operational Procedures

Survey gear

The basic unit of survey gear is termed a skate. A skate consists of 100-m (55 fm) of line with 45 hooks spaced 2-m (6.5 ft) apart and baited with squid. A longline set consists of 80 skates with weights between each skate. The gear sinks to the sea floor where it samples fish near the bottom.

The objective of the setting pattern is to evenly distribute sampling effort over depths of about 150-1,000 m. The same station locations have been sampled all survey years. The gear is set from shallow to deep and retrieved in the same order.

Sub-Protocol 1a: Baiting of gear

Bait specification
East Coast or North Atlantic squid (*Illex illecebrosus*), 2-3 count per lb or larger, is the survey standard; *Loligo* or market squid is not acceptable. The general commercial designation is brown color, fit for human consumption (used as an index of freshness), 100-200 grams per squid. The mantle length should be 15-23 cm (6-9 in) long.

Bait size
The mantle is cut into 3-4 pieces, each 4-5 cm (1.5-2 in) long. Only the mantle and viscera are used for bait. The head and tentacles are not used for bait.

Baiting method and quality
Blocks of bait, usually 20 kg (44 lb) in weight, are taken from the freezer the evening before baiting. The bait thaws overnight, but remains semi-frozen when baiting occurs. The squid are individually separated, chopped into pieces, and then returned to the freezer. The chopped squid are taken from the freezer to partially thaw before baiting.

Each hook is hand baited with chopped squid at a rate of about 5.5 kg (12 lb) per 100 hooks. The hooks are baited with semi-frozen squid. Semi-frozen squid are firm and easier to bait than completely thawed squid, which are slippery and hard to handle. The gear is baited, maintained, and coiled into tubs the day before deployment. The bait remains cool due to ambient air temperature, which is 4-15_C. If gear deployment is delayed, the chief scientist will monitor bait quality for freshness. For deployment, the bait must be fit for human consumption. Bait deterioration can be detected by change in color to dark reddish-brown, dryness, and smell.

Sub-Protocol 1b: Setting and hauling

Setting takes 1-1/2 to 2 hours. The vessel travels at 6-7 knots. Retrieval begins at the same end where deployment began. Retrieval lasts 7 to 9 hours, depending on station depth and sea conditions. The vessel travels at about 1 knot.

Sub-Protocol 1c: Soak time and gear length

The gear soaks from three to nine hours. Gear retrieval begins after the gear has soaked three hours. The longer soak times occur because of the lengthy time needed to retrieve the gear. One-hundred sixty skates are set each day, totaling 16 km (8.6 n. mi.). The gear is set in two equal parts of 80 skates laid end to end.

Sub-Protocol 1d: Direction of set

The set direction follows the prevailing current. The same station tracks are followed each year. The standard station tracks are recorded on maps in both electronic and paper formats. The vessel track each year is recorded with GPS-linked electronic navigation software to verify that the standard station track is followed.

Sub-Protocol 1e: Bottom topography

Station locations were chosen regardless of bottom topography even though the sampled area, the upper continental slope, is often steep and irregular. The gear is slack and can follow irregularities because the setting speed is moderate. The negative buoyancy of the groundline and the lead balls sink the gear to the bottom. Station tracks avoid gear hangups such as boulders, coral, and lost fishing gear.

Sub-Protocol 1f: Daily schedule

The vessel typically arrives at a station the night before sampling. The captain may transit the standard station track to familiarize himself with the bottom. The gear is set each morning starting at 6:30 AM. Retrieval begins at 9:30 AM, which allows a minimum of 3 hours of soak time. Retrieval and data collection continues until completion, usually about 1800-2200 hours, with a lunch break between retrieval of the two sets. Hooks are baited and gear is repaired throughout each day to ready gear for the following day. The vessel travels to the next day's station following hauling.

Sub-Protocol 1g: Criteria for deploying longline gear

Longline gear is not deployed if weather and sea conditions exceed 10 foot seas and 25-35 knot winds. In these conditions fish drop off the longline and the abundance index is biased. Sampling is delayed until the weather improves so that the affected station is not skipped. Typically weather delays the survey only by one day every 3-4 years. If weather conditions worsen during retrieval hauling continues until all gear is retrieved.

Fishing vessels occasionally fish at or near survey locations. The survey station is moved if the fishing location overlaps the survey location. When a small amount of gear (less than ten skates) is within 0.5 n. mi. (0.9 km), then the station track is slightly shifted. When a large amount of gear (more than ten skates) is within 0.5 n. mi. or the exact fishing locations are unknown, then the station is moved 3-5 n. mi. (5.6-9.3 km) away. The objective of the setting pattern at the alternate station location is to evenly distribute the sampling effort (gear) over depths of about 150-1,000 m.

Killer whales sometimes remove fish from the gear. The killer whales may follow the survey vessel from one station to the next. If this occurs, the station sampling order may be changed to avoid continued depredation.

Sub-Protocol 1h: Criteria for a successful longline set

Status of all hooks are recorded at retrieval. Hooks are classified as ineffective if they are broken, bent, or tangled. This information is used to analyze the survey data after the survey is complete. If six or more of the forty-five hooks of a skate are ineffective, then the skate is declared ineffective and not included in computations of catch rate. If fewer than six hooks are ineffective, then the catch rate is adjusted by the number of ineffective hooks (i.e. only effective hooks are considered in computation of effort and catch rate).

Gear occasionally is lost during retrieval. Typically this occurs when the gear hangs on the bottom and breaks.   If the gear breaks the vessel travels to the second buoy of the set to retrieve the rest of the gear. Occasionally the gear breaks again and gear is lost. If twenty or more skates are lost the vessel typically attempts to retrieve the lost gear by dragging for it with a grapple. Stations are not repeated due to lost gear because gear loss each year has been less than 0.5 percent of survey effort. Catches from lost gear are not recorded.

Killer whales sometimes remove fish from the gear. These occurrences are documented in specialized forms intended to quantify marine mammal interactions. Whale damaged fish are coded in the electronic catch forms. Catches are adjusted for killer whale depredation because removals are large, easily detected and documented, and we have historic information on occurrence to adjust historic catches.

Sperm whales sometimes remove fish from the gear during retrieval. These occurrences are documented in the marine mammal interaction forms. Whale damaged fish are coded in the electronic catch forms. Catches are not adjusted for sperm whale depredation because the removals are small, depredation occurs only occasionally, and we lack historic information on the occurrence to adjust historic catches.

Protocol 2: Longline Gear Construction, repair and Maintenance

Sub-Protocol 2a: Gear construction and configuration

Skates of gear are 100-m (55-fm) long and contain forty-five size 13/0 Mustad1 circle hooks (Figure 2). Hooks are attached to 38-cm (15-in) tied length (untied length 74-cm [29-in]) gangions secured to 46-cm (18-in) beckets tied into the groundline at 2-m (6.5-ft) intervals. Lengths of gangion and becket material are cut by burning. Gangion eyes are 10-cm (4-in) long. Hooks are hung by inserting the tied end of the gangion through the eye face closest to the hook tip (the inside of the hook). The groundline of each skate is marked with bright-colored flagging and red ink at the first and forty-fifth beckets, and with red ink at the remaining forty-three beckets; line marks are to allow equal hook spacing each time the hooks are deployed or the line is repaired. Five meters (16 ft) of groundline are left bare on each end. Skate eyes are 46-cm (18-in) long. The splice to form the eye is tapered, but the ends are not burned because the burned ends abrade the surrounding line when it is stretched. Gangion, becket, and groundline materials are medium lay #60 thread, medium lay # 72 thread, and soft medium lay 9.5 mm (3/8 in) American Line SSR 100 (or equivalent nylon line), respectively.

A set consists of 80 skates, is 8-km (4.3-nmi) long, and contains 3,600 hooks. Each end of a set has a flag and buoy array, followed by a buoyline made of 183-1,281 m (100-700 fm) American

Line (length depends on water depth) and 92 m (50 fm) of 9.5-mm (3/8-in) polypropylene line, a 16-kg (35-lb) piece of chain to dampen wave effects on the buoyline, 92-m (50-fm) American Line, a 27-kg (60-lb) halibut anchor, 366-m (200-fm) American Line, and finally the groundline with hooks. Buoyline length varies with water depth and is 92-276 m (50-150 fm) greater than water depth. The groundline is weighted with 3.2-kg (7-lb) lead balls attached at the end of each skate. The lead balls are tied to a stainless steel snap with a 20-cm (8-in) tied length polypropylene line of 6.2-mm (1/4-in) diameter.

Sub-Protocol 2b: Measurement of hook spacing during gear construction
A template is used to mark hook spacing during gear construction. NOAA personnel construct the longline skates in the Net Loft at the Alaska Fisheries Science Center in Seattle. The groundline is laid across the floor and stretched until straight. Painted marks on the floor spaced 2-m apart are used as a template to mark hook spacing with a red marker. Beckets are inserted at the red marks and gangions are attached. All construction except attachment of hooks is completed by NOAA personnel.

Sub-Protocol 2c: Gear maintenance
The gear is maintained to the following standard aboard the vessel. If the groundline is damaged in a short interval of line, the worn line is replaced by splicing such that the replacement line maintains hook spacing of 2 m. A splice consists of 3 tucks for each line end. Damage includes chafing, nicks, and wear. Gangions and beckets are replaced when the outer covering is worn or broken. Hooks are replaced when severely bent or broken. Slightly bent hooks are straightened. If the groundline is damaged over a long interval, the damaged skate is replaced with new gear built by NOAA personnel at the Net Loft.

Sub-Protocol 2d: Measurement of hook spacing during gear maintenance
Marks placed 2-m apart at each baiting and repair station are used to measure hook spacing after splicing.

Protocol 3: Rationale for gear configuration and survey methods

Sub-Protocol 3a: Survey area
The survey area covers nearly all adult sablefish habitat in the Alaska EEZ.

Sub-Protocol 3b: Station placement
The longline survey follows a systematic design (Sasaki 1985) by placing stations 20-30 nmi (37-56 km) apart and sampling these same locations every year. Experiments comparing systematically located survey stations to nearby, randomly placed stations found no substantial difference in catch rates.

Sub-Protocol 3c: Gear configuration
Two gear configurations have been used during the history of sablefish longline surveys in Alaska. The original gear used during the Japan-U.S. cooperative longline survey followed the configuration of the Japanese longline fishery in Alaska. The configuration was 100-m skates with 2-m spacing between hooks, tara hooks (a kind of J-hook) baited with squid and attached by

1-m long, lightweight gangions, and 3-kg weights between skates. The gear used during the domestic longline surveys followed the materials of the U.S. longline fishery, but maintained the hook and skate spacing configuration of the cooperative longline survey. The configuration of both surveys is 100-m skates with 2-m spacing between hooks, baited with squid, and 3-kg weights between skates. The domestic longline survey uses circle hooks and shorter, heavy-weight gangions.

Sub-Protocol 3d: Relationship of catch rate and abundance

Several experiments have been conducted to test whether survey catch rate is a linear function of abundance (Sigler 2000). Hook timer, on-bottom (soak) time, hook density, hook pattern, bait type, and bait condition experiments and mathematical models were used to evaluate the performance of the longline surveys for estimating sablefish relative abundance. The rate that sablefish encountered the longline gear decreased with on-bottom time independently of sablefish density in the sampled area. Sablefish were adept at locating available baits, even when few remained. The decrease in encounter rate appears related to odor concentration at the leading edge of the odor plume. The ability to locate baits, even when few remain, differs from previous models of fish capture by longline in which the probability that a fish located a bait was proportional to the number of available baits. Decreased encounter rate and the ability to locate baits efficiently imply that longline catch rates likely provide an accurate index of fish abundance if the on-bottom time is long enough to cover the period when most fish encounter the gear and the initial bait density is high enough that baits remain available throughout the soak; the weak link between catch rate and abundance is the unknown extent that factors such as temperature and food availability affect the proportion of fish caught.

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Sasaki, T. 1985. Studies on the sablefish resources in the North Pacific Ocean. Far Seas Fisheries Research Lab. Bull. 22:1-108.

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Tables and figures

16
box
1800-ft length of American Line SSR 100 soft/medium lay (groundline)
3600
each
Mustad #39965-13/0 hooks
25
pounds
Medium lay #60 thread round braided nylon gangion twine
10
pounds
Medium lay #72 thread becket material
81
each
7 lb. lead balls with eyelets
81
each
Stainless steel groundline snaps for 3/8" groundline
108
feet
Polypropylene braided line 1/4" diameter
2
each
Flags
4
each
Buoys
5
box
1800-ft length of American Line SSR 100 soft/medium lay (buoyline)
100
fm
9.5 mm (3/8") polypropylene line
2
each
16 kg (35 lb) piece of chain
2
box
American Line SSR 100 soft/medium lay (line from chain to anchor and anchor to groundline)
2
each
27 kg (60 lb) halibut anchor

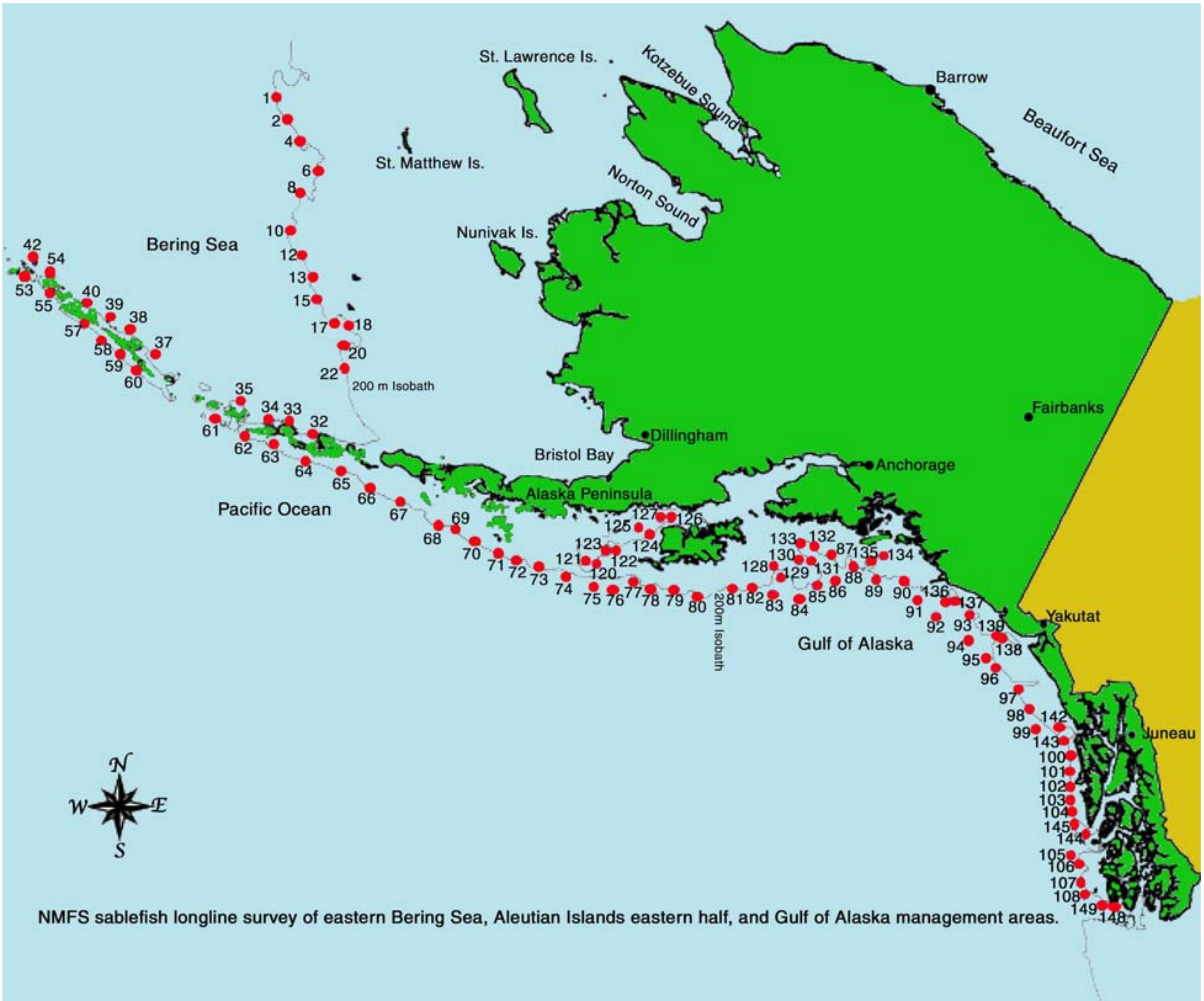

Figure 1.–Survey area for Alaska sablefish longline survey.

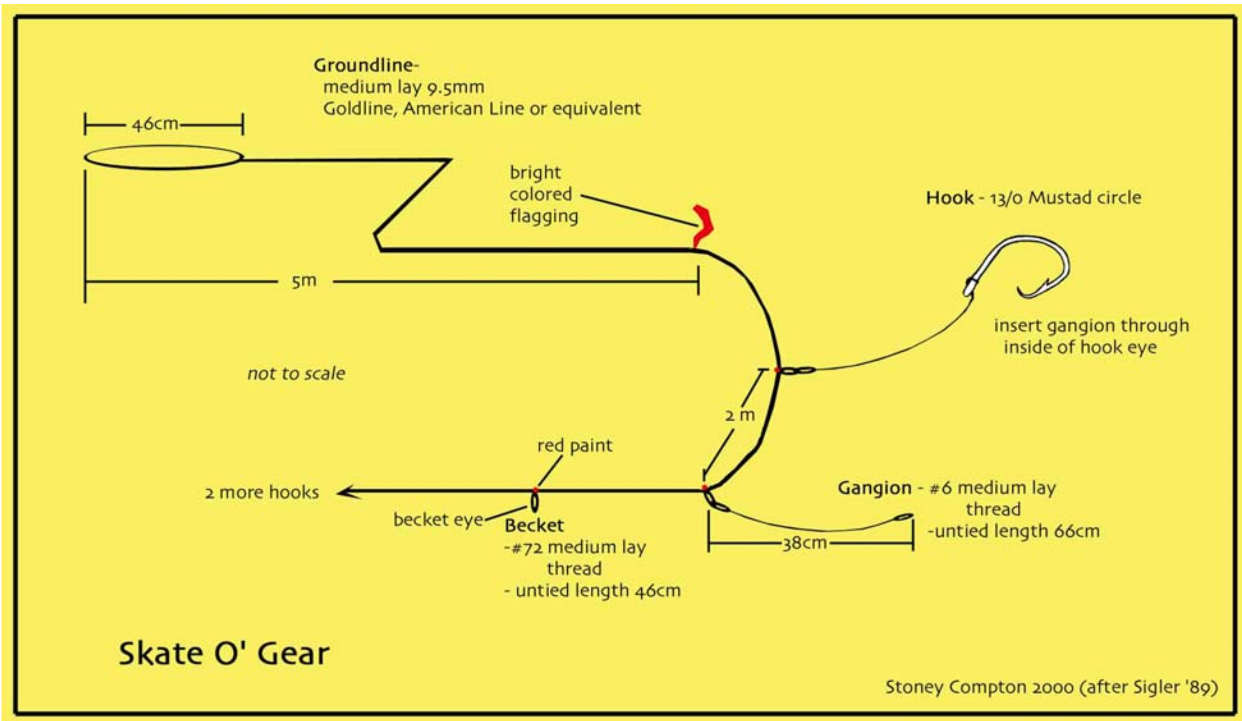

Figure 2.–Diagram of one skate of longline gear.